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Zulassungsstelle für Bauprodukte und Bauarten
Bautechnisches Prüfamt
Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

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Authorised and notified according to Article 10 of the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products (89/106/EEC)

Deutsches Institut für Bautechnik DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-08/0290

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	Powers AC100-PRO Verbundmörtel mit Ankerstange *Powers AC100-PRO injection resin with anchor rod*
Zulassungsinhaber *Holder of approval*	Powers Fasteners Europe Stanley Black&Decker Deutschland GmbH Black-&-Decker Str. 40 65510 Idstein DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	Verbunddübel zur Verankerung im Beton unter statischer, quasi-statischer oder seismischer Einwirkung (Leistungskategorie C1) *Bonded anchor for use in concrete under static, quasi-static or seismic action (performance category C1)*
Geltungsdauer: *Validity:* vom *from*	15 March 2013
bis *to*	15 March 2018
Herstellwerk *Manufacturing plant*	Powers Fasteners Europe BV Factory 2, Germany

Diese Zulassung umfasst *This Approval contains*	45 Seiten einschließlich 36 Anhänge *45 pages including 36 annexes*
Diese Zulassung ersetzt *This Approval replaces*	ETA-08/0290 mit Geltungsdauer vom 11.06.2010 bis 13.11.2013 *ETA-08/0290 with validity from 11.06.2010 to 13.11.2013*

I LEGAL BASES AND GENERAL CONDITIONS

1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:

- Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];
- Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998[4], as amended by Article 2 of the law of 8 November 2011[5];
- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];
- Guideline for European technical approval of "Metal anchors for use in concrete - Part 5: Bonded anchors", ETAG 001-05.

2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.

3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.

4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.

5 Reproduction of this European technical approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Deutsches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European technical approval.

6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

1 Official Journal of the European Communities L 40, 11 February 1989, p. 12
2 Official Journal of the European Communities L 220, 30 August 1993, p. 1
3 Official Journal of the European Union L 284, 31 October 2003, p. 25
4 *Bundesgesetzblatt Teil I 1998*, p. 812
5 *Bundesgesetzblatt Teil I 2011*, p. 2178
6 Official Journal of the European Communities L 17, 20 January 1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

1.1 Definition of the construction product

The Powers AC100-PRO injection resin with anchor rod for non-cracked concrete is a bonded anchor consisting of a cartridge with injection mortar AC100 PRO and a steel element. The steel elements are threaded rods acc. to Annex 4 in the range of M8 to M30, a reinforcing bar acc. to Annex 5 in the range of diameter 8 to 32 mm or an internal threaded sleeve of sizes M8 to M20 acc. to Annex 6.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

An illustration of the product and intended use is given in Annexes 1 and 2.

1.2 Intended use

The anchor is intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106 EEC shall be fulfilled and failure of anchorages made with these products would cause risk to human life and/or lead to considerable economic consequences. Safety in case of fire (Essential Requirement 2) is not covered in this European technical approval.

The anchor is to be used only for anchorages subject to static or quasi-static action in reinforced or unreinforced normal weight concrete of strength classes C20/25 at minimum and C50/60 at most according to EN 206:2000-12.

The anchor may be used in cracked and non-cracked concrete.

The anchor with threaded rods or rebar may also be used under seismic action (anchor performance category C1).

The anchor may be installed in dry or wet concrete.

The anchor for applications under static or quasi-static action may also be installed in flooded holes up to drill hole diameter d_0 ≤ 18 mm.

The anchor may be used in the following temperature ranges:

Temperature range I:	-40 °C to +40 °C	(max long term temperature +24 °C and max short term temperature +40 °C)
Temperature range II:	-40 °C to +80 °C	(max long term temperature +50 °C and max short term temperature +80 °C)
Temperature range III:	-40 °C to +120 °C	(max long term temperature +72 °C and max short term temperature +120 °C)

<u>Elements made of zinc coated steel:</u>

The element made of zinc plated or hot-dip galvanised steel may only be used in structures subject to dry internal conditions.

Elements made of stainless steel A4:

The element made of stainless steel 1.4401, 1.4404 or 1.4571 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure (including industrial and marine environment), or exposure to permanently damp internal conditions, if no particular aggressive conditions exist. Such particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Elements made of high corrosion resistant steel:

The element made of high corrosion resistant steel 1.4529 or 1.4565 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions. Such particular aggressive conditions are e. g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Elements made of reinforcing bars:

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the reinforcing bars act as dowels to take up shear forces. Connections with post-installed reinforcing bars in concrete structures designed in accordance with EN 1992-1-1: 2004 are not covered by this European technical approval.

The provisions made in this European technical approval are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

2 Characteristics of the product and methods of verification

2.1 Characteristics of the product

The anchor corresponds to the drawings and provisions given in the Annexes. The characteristic material values, dimensions and tolerances of the anchor not indicated in the Annexes shall correspond to the respective values laid down in the technical documentation[7] of this European technical approval.

The characteristic values for the design of anchorages are given in the Annexes.

The two components of the injection mortar are delivered in unmixed condition in coaxial cartridges of sizes 160 ml, 300 ml, 360 ml or 420 ml or in side-by side-cartridges of sizes 235 ml, 360 ml or 825 ml or in foil tubes of size 165 ml or 300 ml according to Annex 2. Each cartridge is marked with the imprint "AC100-PRO", with processing notes, charge code, storage life, hazard code and curing- and processing time depending on temperature and with as well as without travel scale.

[7] The technical documentation of this European technical approval is deposited at the Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

Elements made of reinforcing bars shall comply with the specification given in Annex 5.

The marking of embedment depth on the steel element may be done on jobsite.

2.2 Methods of verification

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 has been made in accordance with the "Guideline for European technical approval of Metal Anchors for Use in Concrete", Part 1 "Anchors in general" and Part 5 "Bonded anchors", on the basis of Option 1 and ETAG 001 Annex E "Assessment of Metal Anchors under Seismic Action".

In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3 Evaluation and attestation of conformity and CE marking

3.1 System of attestation of conformity

According to the Decision 96/582/EG of the European Commission[8] system 2(i) (referred to as System 1) of the attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 1: Certification of the conformity of the product by an approved certification body on the basis of:

(a) Tasks for the manufacturer:

  (1) factory production control;

  (2) further testing of samples taken at the factory by the manufacturer in accordance with a control plan;

(b) Tasks for the approved body:

  (3) initial type-testing of the product;

  (4) initial inspection of factory and of factory production control;

  (5) continuous surveillance, assessment and approval of factory production control.

Note: Approved bodies are also referred to as "notified bodies".

3.2 Responsibilities

3.2.1 Tasks for the manufacturer

3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use initial/raw/constituent materials stated in the technical documentation of this European technical approval.

8 Official Journal of the European Communities L 254 of 08.10.1996

The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Deutsches Institut für Bautechnik.[9]

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

3.2.1.2 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of anchors in order to undertake the actions laid down in section 3.2.2 For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of this European technical approval.

3.2.2 Tasks for the approved bodies

The approved body shall perform the

- initial type-testing of the product,
- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control,

in accordance with the provisions laid down in the control plan.

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

3.3 CE marking

The CE marking shall be affixed on each packaging of the anchor. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the producer (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate of conformity for the product,
- the number of the European technical approval,
- the number of the guideline for European technical approval,
- use category (ETAG 001, Option 1 for all steel elements and seismic anchor category C1 for threaded rods and rebar only),
- size.

9 The control plan is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

The European technical approval is issued for the product on the basis of agreed data/information, deposited at Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

4.2 Design of anchorages

The fitness of the anchor for the intended use is given under the following conditions:

The anchorages are designed either in accordance with the

The anchorages are designed in accordance with

- EOTA Technical Report TR 029 "Design of bonded anchors"[10]

or in accordance with

- CEN/TS 1992-4:2009,

and EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action" under the responsibility of an engineer experienced in anchorages and concrete work.

The anchorages shall be positioned outside of plastic hinges of the concrete structure. Fastenings in stand-off installation or with a grout layer under seismic action are not covered.

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. The basic assumptions for the design according to anchor theory shall be observed. This includes the consideration of tension and shear loads and the corresponding failure modes as well as the assumption that the base material (concrete structural element) remains essentially in the serviceability limit state (either non-cracked or cracked) when the connection is loaded to failure. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the reinforcing bars act as dowels to take up shear forces. Connections with reinforcing bars in concrete structures designed in accordance with EN1992-1-1:2004 (e.g. connection of a wall loaded with tension forces in one layer of the reinforcement with the foundation) are not covered by this European technical approval.

Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored.

The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.).

10 The Technical Report TR 029 "Design of Bonded Anchors" is published in English on EOTA website www.eota.eu.

4.3 Installation of anchors

The fitness for use of the anchor can only be assumed if the anchor is installed as follows:

- anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site,
- anchor installation in accordance with the manufacturer's specifications and drawings using the tools indicated in the technical documentation of this European technical approval,
- use of the anchor only as supplied by the manufacturer without exchanging the components,
- commercial standard threaded rods, washers and hexagon nuts may be used if the following requirements are fulfilled:
  - material, dimensions and mechanical properties of the metal parts according to the specifications given in Annex 4,
  - confirmation of material and mechanical properties of the metal parts by inspection certificate 3.1 according to EN 10204:2004, the documents should be stored,
  - marking of the threaded rod with the envisage embedment depth. This may be done by the manufacturer of the rod or the person on jobsite.
- embedded reinforcing bars shall comply with specifications given in Annex 5,
- checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower than that of the concrete to which the characteristic loads apply,
- check of concrete being well compacted, e.g. without significant voids,
- marking and keeping the effective anchorage depth,
- edge distance and spacing not less than the specified values without minus tolerances,
- positioning of the drill holes without damaging the reinforcement,
- drilling by hammer-drilling only,
- in case of aborted drill hole: the drill hole shall be filled with mortar,
- cleaning the drill hole in accordance with Annexes 8 and 9,
- before injection the temperature of the cartridges shall be at least +5 °C and not more than +25 °C, the temperature of the cartridge must be at least +15°C if the temperature of the concrete member is below -5°C,
- during installation and curing of the chemical mortar the temperature of the concrete member shall be at least -10 °C;
- for injection of the mortar in bore holes of diameter d_0 > 20 mm piston plugs acc. Annex 10 shall be used for overhead or horizontal injection,
- observing the curing time according to Annex 9, Table 5 until the anchor may be loaded,
- installation torque moments are not required for functioning of the anchor. However, the torque moments given in Annex 7 must not be exceeded.

5 Recommendations concerning packaging, transport and storage

5.1 Responsibility of the manufacturer

The manufacturer is responsible to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to and 4.2, 4.3 and 5.2 is given to those who are concerned. This information may be made by reproduction of the respective parts of the European technical approval.

In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

- drill bit diameter,
- hole depth,
- nominal diameter of anchor rod,
- minimum effective anchorage depth,
- information on the installation procedure, including cleaning of the hole with the cleaning equipments, preferably by means of an illustration,
- anchor component installation temperature,
- ambient temperature of the concrete during installation of the anchor,
- admissible processing time (open time) of the mortar,
- curing time until the anchor may be loaded as a function of the ambient temperature in the concrete during installation,
- maximum torque moment,
- identification of the manufacturing batch,

All data shall be presented in a clear and explicit form.

5.2 Packaging, transport and storage

The cartridges shall be protected against sun radiation and shall be stored according to the manufacturer's installation instructions in dry condition at temperatures of at least +5 °C to not more than +25 °C.

Cartridges with expired shelf life must no longer be used.

The anchor shall only be packaged and supplied as a complete unit. Cartridges may be packed separately from metal parts.

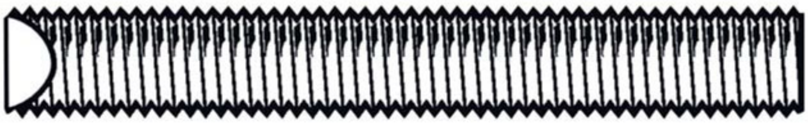
Andreas Kummerow
p. p. Head of Department

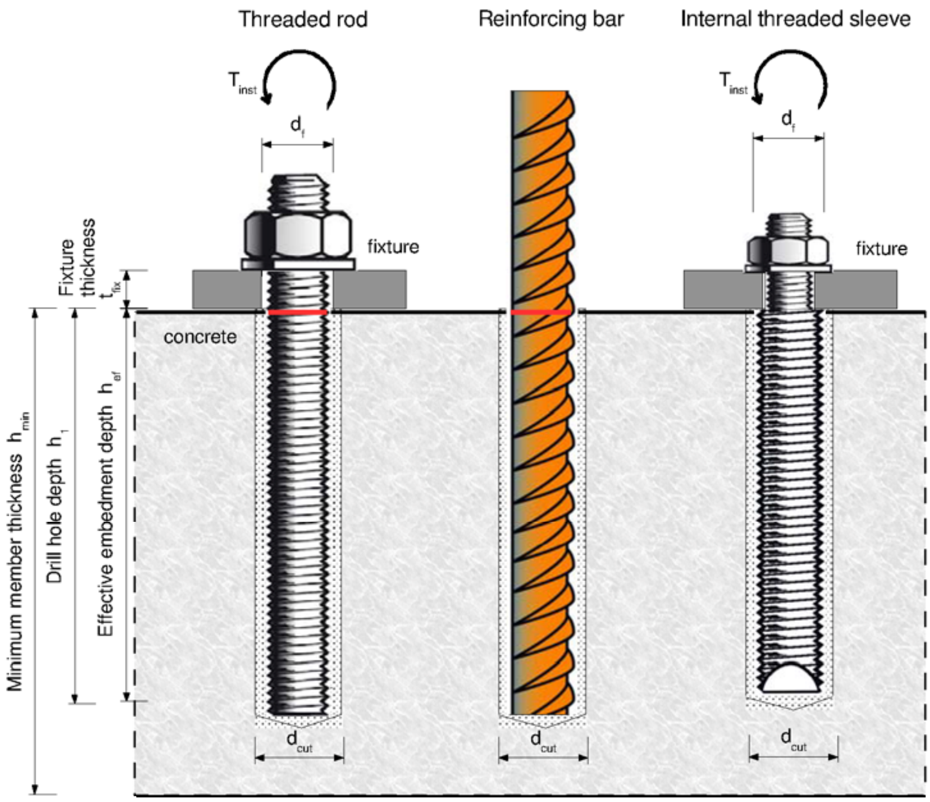
beglaubigt:
Lange

Threaded rod M8, M10, M12, M16, M20, M24, M27 and M30 with washer and nut

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28 and ∅ 32 acc. to Annex 4

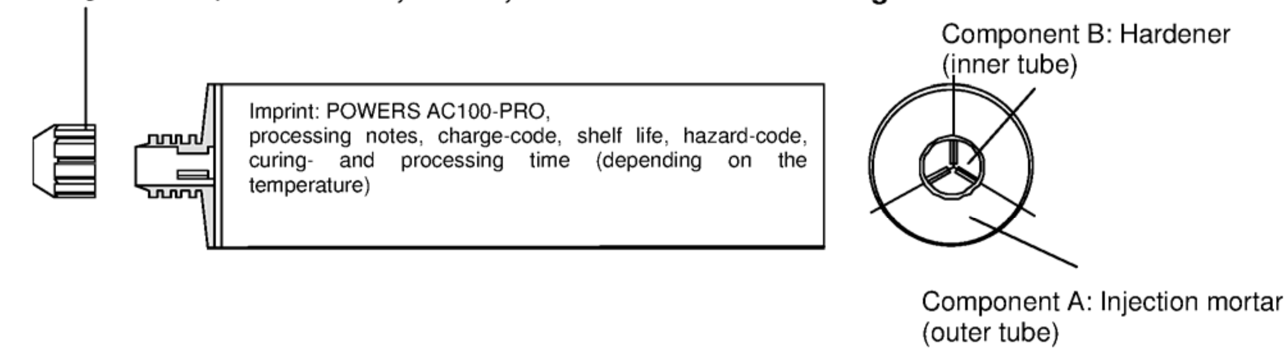
Internal threaded sleeve M8, M10, M12, M16 and M20



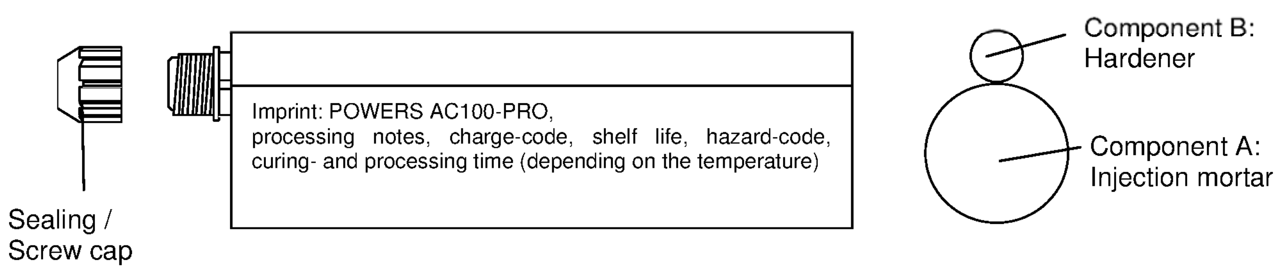


Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 1**
Product and Installation	

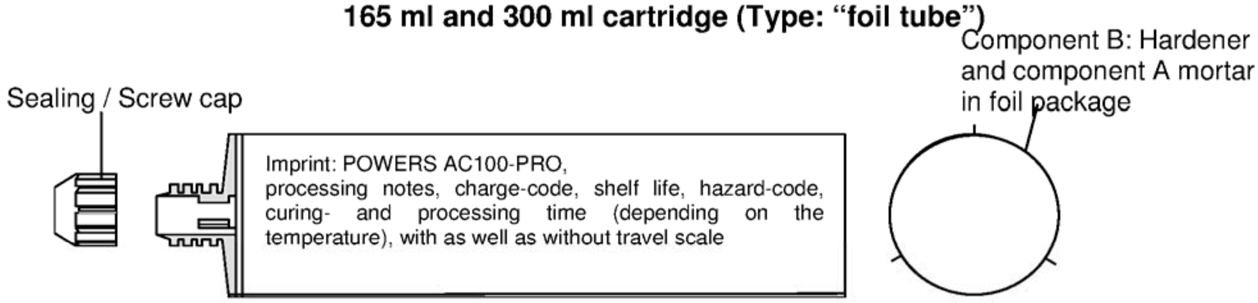
160 ml, 300 ml, 360 ml and 420 ml cartridge



235 ml, 360 ml and 825 ml cartridge (Type: "side-by-side")



165 ml and 300 ml cartridge (Type: "foil tube")



Static Mixer

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 2**
Product (Injection mortar)	

Use category:

- Installation in dry or wet concrete
  Static and quasi-static actions (all steel elements)
  Anchor seismic performance category C1 (for threaded rods and rebar only)

- Installations in flooded holes for drill hole diameter $d_0 \leq 18$ mm
  Static and quasi-static actions only (all steel elements)

- Overhead installation

- Application in cracked concrete, option 1

Temperature ranges:

- 40°C to +40°C (max. short term temp. +40°C and max. long term temp. +24°C)

- 40°C to +80°C (max. short term temp. +80°C and max. long term temp. +50°C)

- 40°C to +120°C (max. short term temp. +120°C and max. long term temp. +72°C)

Design options:

- Annexes 11 to 22
  - Design according to TR029:
    - For static and quasi-static loading only
    - Design for applications in cracked and non cracked concrete

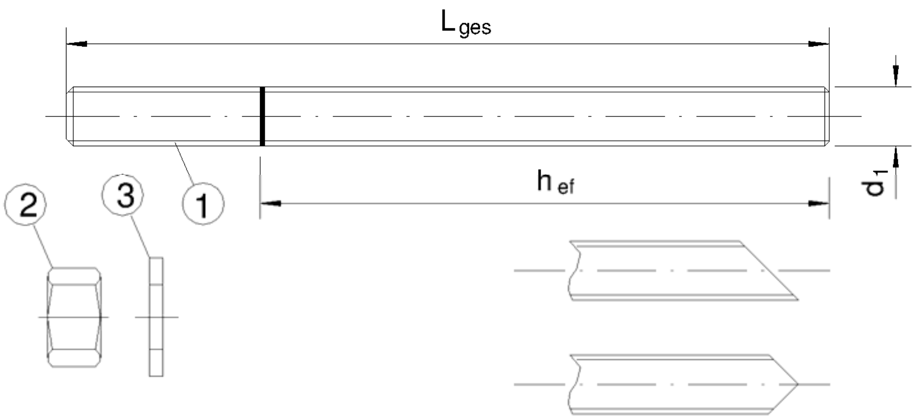
- Annexes 23 to 34
  - Design according to CEN/TS 1992-4
    - For static and quasi-static loading
    - Design for applications in cracked and non cracked concrete

- Annexes 35 to 36
  - Design for seismic action according to Technical Report "Design of Metal Anchors under Seismic Action"
    - Anchor seismic performance category C1 (see Annex 35)

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 3**
Use categories, temperature ranges and design options	

Deutsches Institut für Bautechnik DIBt

Table 1a: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461 and EN ISO 10684		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 5.8, 8.8, EN ISO 898-1:1999
2	Hexagon nut, EN ISO 4032	Property class 5 (for class 5.8 rod) EN ISO 898-2, Property class 8 (for class 8.8 rod) EN ISO 20898-2
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Steel, zinc plated or hot-dip galvanised
Stainless steel A4		
1	Anchor rod	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4401 / 1.4404 / 1.4571 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4401, 1.4404 or 1.4571, EN 10088
High corrosion resistance steel HCR		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088

Commercial standard rod with:
- Materials, dimensions and mechanical properties acc. Table 1a
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 4**
Materials (Threaded rod)	

Table 1b: Materials (Rebar)

Abstract of EN 1992-1-1 Annex C, Table C.1, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Characteristic yield strength f_{yk} or $f_{0,2k}$ [N/mm²]		400 to 600	
Minimum value of $k = (f_t / f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} [%]		≥ 5,0	≥ 7,5
Bendability		Bend/Rebend test	
Maximum deviation from nominal mass (individual bar) [%]	Nominal bar size [mm] ≤ 8 mm > 8 mm	± 6,0 ± 4,5	

Abstract of EN 1992-1-1 Annex C, Table C.2N, Properties of reinforcement:

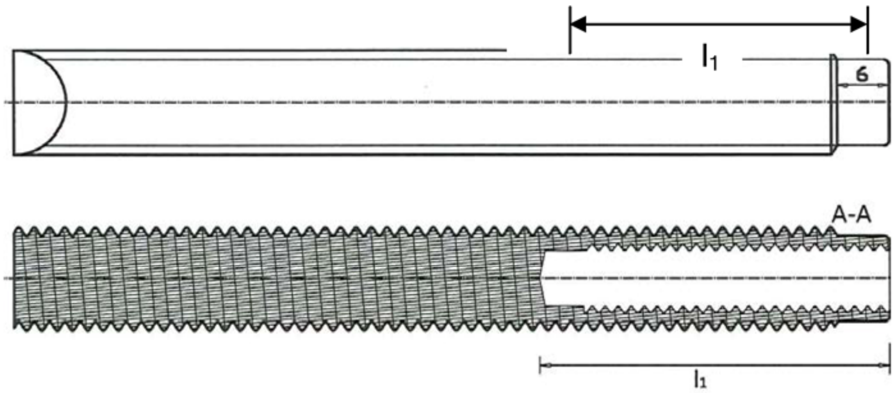
Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Min. value of related rib area $f_{R,min}$	nominal diameter of the rebar [mm] 8 mm to 12 mm > 12 mm	0,040 0,056	

Rib height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
(d: Nominal diameter of the bar; h: Rib height of the bar)

Regarding design of post-installed rebar as anchor see Section 4.2

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 5**
Materials (Reinforcing bar)	

Table 1c: Materials (Internal threaded sleeve)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042		
1	Internal threaded sleeve	Steel, EN 10087 or EN 10263 Property class 5.8, EN ISO 898-1:1999
2	Corresponding steel screw	Steel screws property class 5.8 or 8.8, EN ISO 898-1 Zinc plated ≥ 5 µm according to EN ISO 4042
Stainless steel A4		
1	Internal threaded sleeve	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506 Stainless steel 1.4401, 1.4404, 1.4571 EN 10088
High corrosion resistance steel HCR		
1	Internal threaded sleeve	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506 High corrosion resistance steel 1.4529, 1.4565 EN 10088

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 6**
Materials (Internal threaded sleeve)	

Table 2: Installation parameters for threaded rod

Anchor size		M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Nominal drill hole diameter	d_0 [mm]	10	12	14	18	24	28	32	35
Effective anchorage depth	$h_{ef,min}$ [mm]	60	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d_f [mm]	9	12	14	18	22	26	30	33
Diameter of steel brush	d_b [mm]	12	14	16	20	26	30	34	37
Torque moment	T_{inst} [Nm]	10	20	40	80	120	160	180	200
Thickness of fixture	$t_{fix,min}$ [mm]	0							
	$t_{fix,max}$ [mm]	1500							
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm			$h_{ef} + 2 \cdot d_0$				
Minimum spacing	s_{min} [mm]	40	50	60	80	100	120	135	150
Minimum edge distance	c_{min} [mm]	40	50	60	80	100	120	135	150

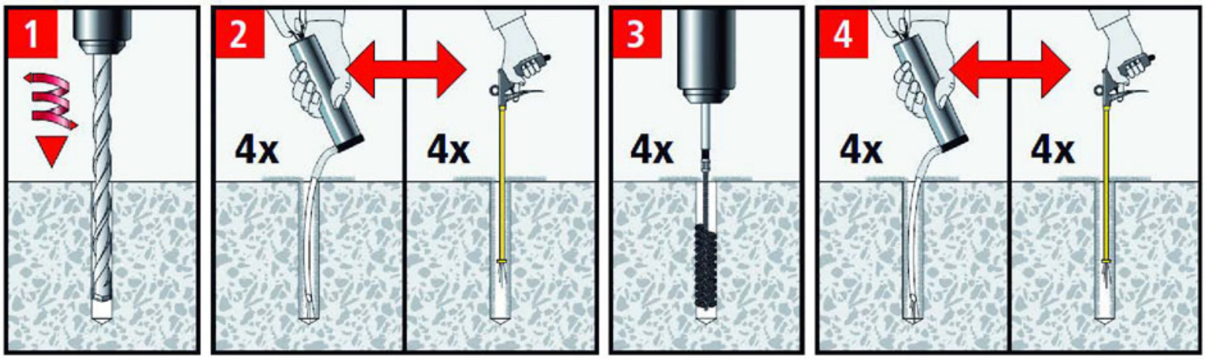
Table 3: Installation parameters for rebar

Rebar size		∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Nominal drill hole diameter	d_0 [mm]	12	14	16	18	20	24	32	35	37
Effective anchorage depth	$h_{ef,min}$ [mm]	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm]	160	200	240	280	320	400	480	540	640
Diameter of steel brush	d_b [mm]	14	16	18	20	22	26	34	37	40
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm	$h_{ef} + 2 \cdot d_0$							
Minimum spacing	s_{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	125	140	160

Table 4: Installation parameters for internal threaded sleeves

Internal thread size		M 8	M 10	M 12	M 16	M 20
External diameter size	[mm]	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm]	14	18	24	28	35
Effective anchorage depth	h_{ef} [mm]	80	90	110	150	200
Diameter of clearance hole in the fixture	d_f [mm]	9	12	14	18	22
Diameter of steel brush	d_b [mm]	16	20	26	30	37
Torque moment	T_{inst} [Nm]	10	20	40	80	120
Min.- max. screw in length	l_1 [mm]	8-35	10-45	12-55	16-75	20-85
Minimum thickness of member	h_{min} [mm]	110	130	160	210	270
Minimum spacing	s_{min} [mm]	60	80	100	120	150
Minimum edge distance	c_{min} [mm]	60	80	100	120	150

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 7**
Installation parameters	



1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table 2, Table 3 or Table 4).

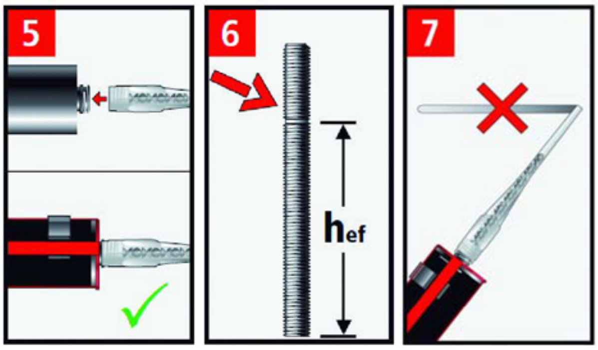
2. Before cleaning remove standing water out of the drill hole. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) or a hand pump (Annex 9) a minimum of four times. If the bore hole ground is not reached an extension shall be used.

   The hand-pump can be used for anchor sizes up to bore hole diameter 20 mm.
   For bore holes larger than 20 mm or deeper than 240 mm, compressed air (min. 6 bar) **must** be used.

3. Check brush diameter (Table 6) and attach the brush to a drilling machine or a battery screwdriver. Starting from the bottom or back of the bore hole, brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table 6) a minimum of four times.
   If the bore hole ground is not reached with the brush, a brush extension shall be used (Table 6).

4. Finally blow the hole clean again with compressed air (min. 6 bar) or a hand pump (Annex 9) a minimum of four times. If the bore hole ground is not reached an extension shall be used.

   The hand-pump can be used for anchor sizes up to bore hole diameter 20 mm.
   For bore holes larger than 20 mm or deeper than 240 mm, compressed air (min. 6 bar) **must** be used.



5. Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. Cut off the foil tube clip before use.
   For every working interruption longer than the recommended working time (Table 5) as well as for new cartridges, a new static-mixer shall be used.

6. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.

7. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour.

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 8**
Installation instructions	

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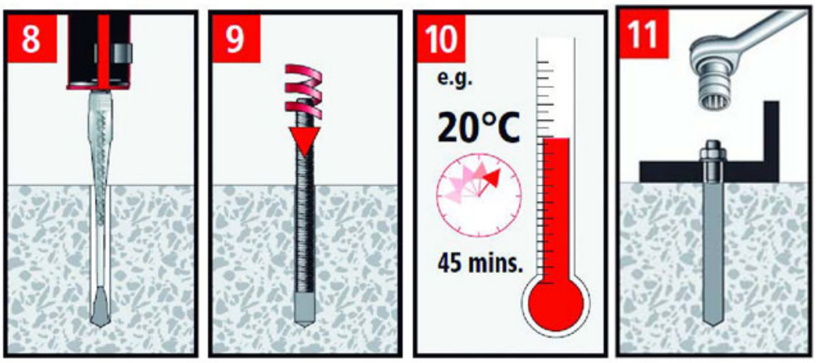


8. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. For overhead and horizontal installation in bore holes larger than ∅ 20 mm a piston plug and extension nozzle (Annex 9) shall be used. Observe the gel-/ working times given in Table 5. Injecting the mortar in with water filled drill holes is allowed for drill diameters smaller than 18 mm.

9. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.
The anchor should be free of dirt, grease, oil or other foreign material.

Be sure that the anchor is fully seated at the bottom of the hole that the annular gap is completely filled with mortar and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application shall not be loaded and has to be renewed.

10. Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table 5).

11. After full curing, the add-on part can be installed with the max. torque moment (Table 2 or Table 4) by using a calibrated torque wrench.

Table 5: Minimum curing time

Concrete temperature	Gelling- / working time	Minimum curing time in dry concrete[2)]
≥ -10 °C [1)]	90 min	24 h
≥ -5 °C	90 min	14 h
≥ 0 °C	45 min	7 h
≥ + 5 °C	25 min	2 h
≥ + 10 °C	15 min	80 min
≥ + 20 °C	6 min	45 min
≥ + 30 °C	4 min	25 min
≥ + 35 °C	2 min	20 min
≥ + 40 °C	1,5 min	15 min

[1)] Cartridge temperature **must** be at min. +15°C
[2)] In wet concrete the curing time **must** be doubled

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 9**
Installation instructions (continuation)	

Steel brush and extension

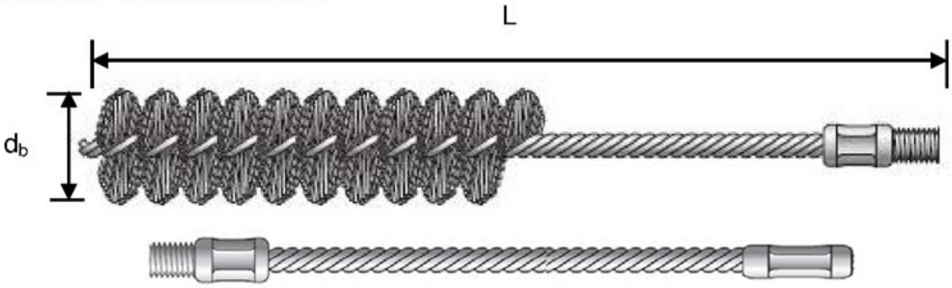
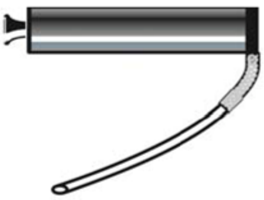


Table 6: Parameter cleaning and setting tools

Threaded rod [mm]	Rebar [mm]	Drill bit ∅ d_0 [mm]	Brushdiameters nominal d_b [mm]	Brushdiameters minimum $d_{b,min}$ [mm]	Total length L [mm]	Piston plug denom. (∅) [mm]
M8		10	12	10,5	170	-
M10	8	12	14	12,5	170	-
M12	10	14	16	14,5	200	-
	12	16	18	16,5	200	-
M16	14	18	20	18,5	300	-
	16	20	22	20,5	300	-
M20	20	24	26	24,5	300	#24 (22)
M24		28	30	28,5	300	#28 (27)
M27	25	32	34	32,5	300	#28 (29)
M30	28	35	37	35,5	300	#35 (34)
	32	37	40	37,5	300	#35 (36)



Hand pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm

Recommended compressed air tool (min 6 bar)
Drill bit diameter (d_0): 10 mm to 37 mm

Piston plug for overhead or horizontal installation
Drill bit diameter (d_0): 24 mm to 37 mm

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 10

Cleaning and setting tools

Table 7: Design according to TR029 Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure											
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,50							
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,87						2,86	
Combined pullout and concrete cone failure											
Characteristic bond resistance in non-cracked concrete C20/25											
dry and wet concrete	Temp. range I 5): 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	11	13	13	13	13	12	11	9,5
dry and wet concrete	Temp. range II 5): 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	9,0	8,0	7,0
dry and wet concrete	Temp. range III 5): 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,0	5,5	5,0
dry and wet concrete	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		1,5 2)	1,8 3)						
flooded bore hole	Temp. range I 5): 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	8,0	9,5	9,5	9,5	not admissible			
flooded bore hole	Temp. range II 5): 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	6,0	7,0	7,0	7,0	not admissible			
flooded bore hole	Temp. range III 5): 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	4,5	5,5	5,5	5,5	not admissible			
flooded bore hole	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		2,1 4)				not admissible			
Increasing factors for non-cracked concrete ψ_c		C30/37		1,04							
Increasing factors for non-cracked concrete ψ_c		C40/50		1,08							
Increasing factors for non-cracked concrete ψ_c		C50/60		1,10							
Splitting failure											
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$							
Partial safety factor (dry and wet concrete)		γ_{Msp} 1)		1,5 2)	1,8 3)						
Partial safety factor (flooded bore hole)		γ_{Msp} 1)		2,1 4)				not admissible			

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) The partial safety factor $\gamma_2 = 1.2$ is included.
4) The partial safety factor $\gamma_2 = 1.4$ is included.
5) Explanation see Section 1.2

Table 8: Design according to TR029 Characteristic values for tension loads in cracked concrete

Anchor size threaded rod			M 12	M 16	M 20	M24	M 27	M 30
Steel failure								
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,50					
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)	$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,87				2,86	
Combined pullout and concrete cone failure								
Characteristic bond resistance in cracked concrete C20/25								
dry and wet concrete: Temp. range I5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5	6,5
dry and wet concrete: Temp. range II5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5	4,5
dry and wet concrete: Temp. range III5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5	3,5
dry and wet concrete: Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		1,8 3)					
flooded bore hole: Temp. range I5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible			
flooded bore hole: Temp. range II5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5				
flooded bore hole: Temp. range III5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5				
flooded bore hole: Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		2,1 4)					
Increasing factors for cracked concrete ψ_c	C30/37		1,04					
	C40/50		1,08					
	C50/60		1,10					
Splitting failure								
Characteristic edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$					
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$					
Partial safety factor (dry and wet concrete)	γ_{Msp} 1)		1,8 3)					
Partial safety factor (flooded bore hole)	γ_{Msp} 1)		2,1 4)		not admissible			

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1.0 is included.
3) The partial safety factor γ_2 = 1.2 is included.
4) The partial safety factor γ_2 = 1.4 is included.
5) Explanation see Section 1.2

Table 9: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25							
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56						2,38	
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25							
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56						2,38	
Concrete pryout failure										
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0							
Partial safety factor	γ_{Mcp} [1)]		1,50							
Concrete edge failure										
See Section 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors										
Partial safety factor	γ_{Mc} [1)]		1,50							

[1)] In absence of other national regulations

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 13**
Application with threaded rod Design method A: Characteristic values for shear loads in cracked and uncracked concrete **Design TR029**	

Table 10: Displacements for tension loads [1] in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Uncracked concrete										
Temperature range I 40°C/24°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,033	0,037	0,045	0,052	0,060	0,065	0,071
Temperature range II 80°C/50°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Temperature range III 120°C/72°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Cracked concrete										
Temperature range I 40°C/24°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105							
Temperature range II 80°C/50°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,170							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245							
Temperature range III 120°C/72°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,170							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245							

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 11: Displacement for shear load [2] in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Uncracked concrete										
Displacement	δ_{V0}	[mm/ kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04
Cracked concrete										
Displacement	δ_{V0}	[mm/ kN]			0,112	0,103	0,093	0,084	0,076	0,069
Displacement	$\delta_{V\infty}$	[mm/ kN]			0,169	0,154	0,140	0,125	0,115	0,104

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 14**
Application with threaded rod Displacements **Design TR029**	

Table 12: Design according to TR029 Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure (Properties acc. to Annex 4)												
Characteristic tension resistance, B500B according to DIN488-2: 2009 [6)]		$N_{Rk,s}$	[kN]	28	43	62	85	111	173	270	339	442
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,40								
Combined pullout and concrete cone failure												
Characteristic bond resistance in uncracked concrete C20/25												
dry and wet concrete	Temp. range I[5)]: 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	11	13	13	13	13	13	11,5	10,5	9,0
	Temp. range II[5)]: 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	9,5	8,5	7,5	6,5
	Temp. range III[5)]: 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ [1)]		1,5[2)]	1,8[3)]							
flooded bore hole	Temp. range I[5)]: 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	not admissible			
	Temp. range II[5)]: 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	6,0	7,0	7,0	7,0	7,0				
	Temp. range III[5)]: 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	4,5	5,5	5,5	5,5	5,5				
	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ [1)]		2,1[4)]								
Increasing factors for non-cracked concrete ψ_c		C30/37		1,04								
		C40/50		1,08								
		C50/60		1,10								
Splitting failure												
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$								
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$								
Partial safety factor (dry and wet concrete)		γ_{Msp} [1)]		1,5[2)]	1,8[3)]							
Partial safety factor (flooded bore hole)		γ_{Msp} [1)]		2,1[4)]					not admissible			

[1)] In absence of other national regulations
[2)] The partial safety factor γ_2 = 1.0 is included.
[3)] The partial safety factor γ_2 = 1.2 is included.
[4)] The partial safety factor γ_2 = 1.4 is included.
[5)] Explanations see section 1.2
[6)] For reinforcing bars which do not comply with DIN 488: The characteristic resistance $N_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.1).

For more information on the design of post-installed rebar as anchor see Section 4.2

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 15**
Application with reinforcing bar Design method A: Characteristic values for tension loads in uncracked concrete **Design TR029**	

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Table 13: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar				Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure (Properties acc. to Annex 4)										
Characteristic tension resistance, B500B according to DIN488-2: 2009 [6]		$N_{Rk,s}$	[kN]	62	85	111	173	270	339	442
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,40						
Combined pullout and concrete cone failure										
Characteristic bond resistance in cracked concrete C20/25										
dry and wet concrete	Temp. range I[5]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
dry and wet concrete	Temp. range II[5]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
dry and wet concrete	Temp. range III[5]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
dry and wet concrete	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ [1]		1,8[3]						
flooded bore hole	Temp. range I[5]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	6,0	not admissible			
flooded bore hole	Temp. range II[5]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	not admissible			
flooded bore hole	Temp. range III[5]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	3,5	not admissible			
flooded bore hole	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ [1]		2,1[4]			not admissible			
Increasing factors for cracked concrete ψ_c		C30/37		1,04						
Increasing factors for cracked concrete ψ_c		C40/50		1,08						
Increasing factors for cracked concrete ψ_c		C50/60		1,10						
Splitting failure										
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$						
Characteristic spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8[3]						
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		2,1[4]			not admissible			

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ is included.
[5] Explanations see section 1.2
[6] For reinforcing bars which do not comply with DIN 488: The characteristic resistance $N_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.1).

For more information on the design of post-installed rebar as anchor see Section 4.2

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 16**
Application with reinforcing bar Design method A: Characteristic values for tension loads in cracked concrete **Design TR029**	

Table 14: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Steel failure without lever arm (Properties acc. Annex 4)											
Characteristic shear resistance, B500B according to DIN488-2: 2009 3)	$V_{Rk,s}$	[kN]	14	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Steel failure with lever arm (Properties acc. Annex 4)											
Characteristic bending moment, B500B according to DIN488-2: 2009 4)	$M^0_{Rk,s}$	[Nm]	33	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Concrete pryout failure											
Factor k in Equation (5.7) of Technical Report TR 029 for the design of bonded anchors			2,0								
Partial safety factor	γ_{Mcp} 1)		1,50 2)								
Concrete edge failure											
See Section 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors											
Partial safety factor	γ_{Mc} 1)		1,50 2)								

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) For reinforcing bars which do not comply with DIN 488: The characteristic resistance $V_{Rk,s}$ shall be determined acc. to Technical Report TR 029, equation (5.5).
4) For reinforcing bars which do not comply with DIN 488: The characteristic resistance $M^0_{Rk,s}$ shall be determined acc. to Technical Report TR 029, equation (5.6b).

Regarding design of post-installed rebar as anchor see chapter 4.2

Table 15: Displacements for tension loads [1] in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Uncracked concrete											
Temperature range I 40°C/24°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
Temperature range II 80°C/50°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Temperature range III 120°C/72°C											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Cracked concrete											
Temperature range I 40°C/24°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07								
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105								
Temperature range II 80°C/50°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17								
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245								
Temperature range III 120°C/72°C											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,17								
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,245								

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 16: Displacement for shear load [2] in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Uncracked concrete											
Displacement	δ_{V0}	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
Uncracked concrete											
Displacement	δ_{V0}	[mm/(kN)]			0,112	0,108	0,103	0,093	0,081	0,074	0,064
Displacement	$\delta_{V\infty}$	[mm/(kN)]			0,169	0,161	0,154	0,140	0,122	0,111	0,097

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 18**
Application with reinforcing bar Displacements **Design TR029**	

Table 17: Design according to TR029 Characteristic values for tension loads in uncracked concrete

Anchor size internal threaded sleeve				M 8	M 10	M 12	M 16	M 20
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance in non-cracked concrete C20/25								
dry and wet concrete	Temp. range I 5): 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	13	13	13	12	9,5
dry and wet concrete	Temp. range II 5): 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	9,5	9,5	9,5	9,0	7,0
dry and wet concrete	Temp. range III 5): 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	6,5	6,5	6,5	6,0	5,0
dry and wet concrete	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		1,8 3)				
flooded bore hole	Temp. range I 5): 40°C/24°C	$\tau_{Rk,uncr}$	[N/mm²]	9,5	9,5	not admissible		
flooded bore hole	Temp. range II 5): 80°C/50°C	$\tau_{Rk,uncr}$	[N/mm²]	7,0	7,0	not admissible		
flooded bore hole	Temp. range III 5): 120°C/72°C	$\tau_{Rk,uncr}$	[N/mm²]	5,5	5,5	not admissible		
flooded bore hole	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		2,1 4)		not admissible		
Increasing factors for non-cracked concrete ψ_c		C30/37		1,04				
Increasing factors for non-cracked concrete ψ_c		C40/50		1,08				
Increasing factors for non-cracked concrete ψ_c		C50/60		1,10				
Splitting failure								
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} 1)		1,8 3)				
Partial safety factor (flooded bore hole)		γ_{Msp} 1)		2,1 4)		not admissible		

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) The partial safety factor $\gamma_2 = 1.2$ is included.
4) The partial safety factor $\gamma_2 = 1.4$ is included.
5) Explanations see Section 1.2

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 19**
Application with internal threaded sleeve Design method A: Characteristic values for tension loads in uncracked concrete **Design TR029**	

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Table 18: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve				M 8	M 10	M 12	M 16	M 20
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance in cracked concrete C20/25								
dry and wet concrete	Temp. range I 5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5
	Temp. range II 5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5
	Temp. range III 5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5
	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		1,8 3)				
flooded bore hole	Temp. range I 5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible		
	Temp. range II 5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5			
	Temp. range III 5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5			
	Partial safety factor	$\gamma_{Mc} = \gamma_{Mp}$ 1)		2,1 4)				
Increasing factors for cracked concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Splitting failure								
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} 1)		1,8 3)				
Partial safety factor (flooded bore hole)		γ_{Msp} 1)		2,1 4)		not admissible		

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1.0 is included.
3) The partial safety factor γ_2 = 1.2 is included.
4) The partial safety factor γ_2 = 1.4 is included.
5) Explanations see Section 1.2

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 20**
Application with internal threaded sleeve Design method A: Characteristic values for tension loads in cracked concrete **Design TR029**	

Table 19: Design according to TR029 Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm							
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25				
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56				
Steel failure with lever arm							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25				
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56				
Concrete pryout failure							
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0				
Partial safety factor	γ_{Mcp} [1)]		1,50				
Concrete edge failure							
See Section 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors							
Partial safety factor	γ_{Mc} [1)]		1,50				

[1)] In absence of other national regulations

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 21**
Application with internal threaded sleeve Design method A: Characteristic values for shear loads in cracked and uncracked concrete **Design TR029**	

Table 20: Displacements for tension loads [1] in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Uncracked concrete							
Temperature range I 40°C/24°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,026	0,031	0,036	0,041	0,049
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,045	0,052	0,060	0,071
Temperature range II 80°C/50°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,063	0,075	0,088	0,100	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,090	0,108	0,127	0,145	0,172
Temperature range III 120°C/72°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,063	0,075	0,088	0,100	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,090	0,108	0,127	0,145	0,172
Cracked concrete							
Temperature range I 40°C/24°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105				
Temperature range II 80°C/50°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245				
Temperature range III 120°C/72°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245				

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1{,}4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1{,}4$;
(τ_{Sd}: design bond strength)

Table 21: Displacement for shear load [2] in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Uncracked concrete							
Displacement	δ_{V0}	[mm/ kN]	0,05	0,04	0,04	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,08	0,06	0,06	0,05	0,04
Cracked concrete							
Displacement	δ_{V0}	[mm/ kN]	0,112	0,103	0,093	0,084	0,069
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,169	0,154	0,140	0,125	0,104

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1{,}4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1{,}4$;
(V_d: design shear load)

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 22

Application with internal threaded sleeve
Displacements

Design TR029

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Table 22: Design according to CEN/TS1992-4 Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure										
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1]		1,50							
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ [1]		1,87						2,86	
Combined pullout and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25										
dry and wet concrete: Temp. range I[5]: 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	11	13	13	13	13	12	11	9,5
dry and wet concrete: Temp. range II[5]: 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	9,0	8,0	7,0
dry and wet concrete: Temp. range III[5]: 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,0	5,5	5,0
flooded bore hole: Temp. range I[5]: 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	9,5	9,5	9,5	not admissible			
flooded bore hole: Temp. range II[5]: 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	7,0	7,0	7,0				
flooded bore hole: Temp. range III[5]: 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	4,5	5,5	5,5	5,5				
Increasing factors for non-cracked concrete ψ_c	C30/37		1,04							
	C40/50		1,08							
	C50/60		1,10							
Factor ref. bond strength $\tau_{Rk,c}$	k_8		10,1							
Concrete cone failure										
Characteristic edge distance	$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$							
Factor concrete cone equation	k_{ucr}		10,1							
Splitting failure										
Characteristic edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1]		1,5[2]	1,8[3]						
Partial safety factor (flooded bore hole)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1]		2,1[4]				not admissible			

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ is included.
[5] Explanation see Section 1.2 of this ETA

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 23

Application with threaded rod
Design method A: Characteristic values for tension loads in uncracked concrete

Design CEN/TS1992-4

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Table 23: Design according to CEN/TS1992-4 Characteristic values for tension loads in cracked concrete

Anchor size threaded rod				M 12	M 16	M 20	M24	M 27	M 30
Steel failure									
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50					
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87				2,86	
Combined pullout and concrete cone failure									
Characteristic bond resistance in cracked concrete C20/25									
dry and wet concrete	Temp. range I[5]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5	6,5
	Temp. range II[5]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5	4,5
	Temp. range III[5]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5	3,5
flooded bore hole	Temp. range I[5]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible			
	Temp. range II[5]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5				
	Temp. range III[5]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5				
Increasing factors for cracked concrete ψ_c		C30/37		1,04					
		C40/50		1,08					
		C50/60		1,10					
Factor ref. bond strength $\tau_{Rk,c}$		k_8		7,2					
Concrete cone failure									
Characteristic edge distance		$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$					
Characteristic spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$					
Factor concrete cone equation		k_{cr}		7,2					
Splitting failure									
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$					
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$					
Part. safety factor (dry/ wet concr.)		$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1]		1,8[3]					
Part. safety factor (flooded hole)		$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1]		2,1[4]	not admissible				

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ is included.
[5] Explanation see Section 1.2 of this ETA

For seismic design see Annexes 35 and 36.

Powers AC100-PRO Injection resin with anchor rod for concrete	**Annex 24**
Application with threaded rod Design method A: Characteristic values for tension loads in cracked concrete **Design CEN/TS1992-4**	

Table 24: Design according to CEN/TS1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Factor bending	k_2		0,80							
Concrete pryout failure										
Factor k_3			2,0							
Partial safety factor	γ_{Mcp} 1)		1,50							
Concrete edge failure			see CEN/TS 1992-4-5, Section 6.3.4							
Partial safety factor	γ_{Mc} 1)		1,50							

1) In absence of other national regulations

For seismic design see Annexes 35 and 36.

Table 25: Displacements for tension loads[1] in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Uncracked concrete										
Temperature range I 40°C/24°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,033	0,037	0,045	0,052	0,060	0,065	0,071
Temperature range II 80°C/50°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Temperature range III 120°C/72°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Cracked concrete										
Temperature range I 40°C/24°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105							
Temperature range II 80°C/50°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245							
Temperature range III 120°C/72°C										
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17							
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245							

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 26: Displacement for shear load[2] in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Uncracked concrete										
Displacement	δ_{V0}	[mm/ kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04
Cracked concrete										
Displacement	δ_{V0}	[mm/ kN]			0,112	0,103	0,093	0,084	0,076	0,069
Displacement	$\delta_{V\infty}$	[mm/ kN]			0,169	0,154	0,140	0,125	0,115	0,104

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Powers AC100-PRO Injection resin with anchor rod for concrete

Application with threaded rod
Displacements

Design CEN/TS1992-4

Annex 26

Table 27: Design according to CEN/TS1992-4 Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure (Properties acc. to Annex 4)												
Characteristic tension resistance, B500B according to DIN488-2: 2009		$N_{Rk,s}$	[kN]	28	43	62	85	111	173	270	339	442
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,40								
Combined pullout and concrete cone failure												
Characteristic bond resistance in uncracked concrete C20/25												
dry and wet concrete	Temp. range I5): 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	11	13	13	13	13	13	11,5	10,5	9,0
	Temp. range II5): 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	9,5	8,5	7,5	6,5
	Temp. range III5): 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
flooded bore hole	Temp. range I5): 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	9,5	9,5	9,5	9,5	not admissible			
	Temp. range II5): 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	7,0	7,0	7,0	7,0				
	Temp. range III5): 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	4,5	5,5	5,5	5,5	5,5				
Increasing factors for non-cracked concrete ψ_c		C30/37		1,04								
		C40/50		1,08								
		C50/60		1,10								
Factor ref. bond strength $\tau_{Rk,c}$		k_8		10,1								
Concrete cone failure												
Characteristic edge distance		$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$								
Characteristic spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$								
Factor concrete cone equation		k_{ucr}		10,1								
Splitting failure												
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$								
Characteristic spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								
Partial safety factor (dry and wet concrete)		$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ 1)		1,5 2)	1,8 3)							
Partial safety factor (flooded bore hole)		$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ 1)		2,1 4)					not admissible			

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) The partial safety factor $\gamma_2 = 1.2$ is included.
4) The partial safety factor $\gamma_2 = 1.4$ is included.
5) Explanations see section 1.2

For more information on the design of post-installed rebar as anchor see Section 4.2

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Table 28: Design according to CEN/TS1992-4 Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar				**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure (Properties acc. to Annex 4)										
Characteristic tension resistance, B500B according to DIN488-2: 2009		$N_{Rk,s}$	[kN]	62	85	111	173	270	339	442
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,40						
Combined pullout and concrete cone failure										
Characteristic bond resistance in cracked concrete C20/25										
dry and wet concrete	Temp. range I[5)]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
	Temp. range II[5)]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
	Temp. range III[5)]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
flooded bore hole	Temp. range I[5)]: 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	6,0	not admissible			
	Temp. range II[5)]: 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5				
	Temp. range III[5)]: 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	3,5				
Increasing factors for cracked concrete ψ_c		C30/37		1,04						
		C40/50		1,08						
		C50/60		1,10						
Factor ref. bond strength $\tau_{Rk,c}$		k_8		7,2						
Concrete cone failure										
Characteristic edge distance		$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$						
Characteristic spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$						
Factor concrete cone equation		k_{cr}		7,2						
Splitting failure										
Characteristic edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$						
Characteristic spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)		γ_{Msp} [1)]		1,8[3)]						
Partial safety factor (flooded bore hole)		γ_{Msp} [1)]		2,1[4)]			not admissible			

[1)] In absence of other national regulations
[2)] The partial safety factor $\gamma_2 = 1.0$ is included.
[3)] The partial safety factor $\gamma_2 = 1.2$ is included.
[4)] The partial safety factor $\gamma_2 = 1.4$ is included.
[5)] Explanations see section 1.2

For more information on the design of post-installed rebar as anchor see Section 4.2
For seismic design see Annexes 35 and 36.

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 28

Application with reinforcing bar
Design method A: Characteristic values for tension loads in cracked concrete

Design CEN/TS1992-4

Table 29: Design according to CEN/TS1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Steel failure without lever arm (Properties acc. Annex 4)											
Characteristic shear resistance, B500B according to DIN488-2: 2009	$V_{Rk,s}$	[kN]	14	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,5								
Steel failure with lever arm (Properties acc. Annex 4)											
Characteristic bending moment, B500B according to DIN488-2: 2009	$M^0_{Rk,s}$	[Nm]	33	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,5								
Factor bending	k_2		0,80								
Concrete pryout failure											
Factor k_3			2,0								
Partial safety factor	γ_{Mcp} [1)]		1,50 [2)]								
Concrete edge failure			see CEN/TS 1992-4-5, Section 6.3.4								
Partial safety factor	γ_{Mc} [1)]		1,50 [2)]								

[1)] In absence of other national regulations
[2)] The partial safety factor $\gamma_2 = 1.0$ is included.

Regarding design of post-installed rebar as anchor see Section 4.2
For seismic design see Annexes 35 and 36.

Table 30: Displacements for tension loads[1] in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Uncracked concrete											
Temperature range I 40°C/24°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
Temperature range II 80°C/50°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Temperature range III 120°C/72°C											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Cracked concrete											
Temperature range I 40°C/24°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07								
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105								
Temperature range II 80°C/50°C											
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17								
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245								
Temperature range III 120°C/72°C											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,17								
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,245								

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd}$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd}$ / 1,4;
(τ_{Sd}: design bond strength)

Table 31: Displacement for shear load[2] in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Uncracked concrete											
Displacement	δ_{V0}	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
Uncracked concrete											
Displacement	δ_{V0}	[mm/(kN)]			0,112	0,108	0,103	0,093	0,081	0,074	0,064
Displacement	$\delta_{V\infty}$	[mm/(kN)]			0,169	0,161	0,154	0,140	0,122	0,111	0,097

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{V\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 30

Application with reinforcing bar
Displacements

Design CEN/TS1992-4

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Table 32: Design according to CEN/TS1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure							
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)	$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,87				
Combined pullout and concrete cone failure							
Characteristic bond resistance in non-cracked concrete C20/25							
dry and wet concrete: Temp. range I 5): 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	12	9,5
dry and wet concrete: Temp. range II 5): 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	9,0	7,0
dry and wet concrete: Temp. range III 5): 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	6,5	6,5	6,5	6,0	5,0
flooded bore hole: Temp. range I 5): 40°C/24°C	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	not admissible		
flooded bore hole: Temp. range II 5): 80°C/50°C	$\tau_{Rk,ucr}$	[N/mm²]	7,0	7,0	not admissible		
flooded bore hole: Temp. range III 5): 120°C/72°C	$\tau_{Rk,ucr}$	[N/mm²]	5,5	5,5	not admissible		
Increasing factors for non-cracked concrete ψ_c	C30/37		1,04				
	C40/50		1,08				
	C50/60		1,10				
Factor ref. bond strength $\tau_{Rk,c}$	k_8		10,1				
Concrete cone failure							
Characteristic edge distance	$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$				
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$				
Factor concrete cone equation	k_{ucr}		10,1				
Splitting failure							
Characteristic edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$				
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ 1)		1,8 3)				
Partial safety factor (flooded bore hole)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ 1)		2,1 4)		not admissible		

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) The partial safety factor $\gamma_2 = 1.2$ is included.
4) The partial safety factor $\gamma_2 = 1.4$ is included.
5) Explanations see Section 1.2 of this ETA

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 31

Application with internal threaded sleeve
Design method A: Characteristic values for tension loads in uncracked concrete

Design CEN/TS1992-4

Table 33: Design according to CEN/TS1992-4 Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure							
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)	$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,87				
Combined pullout and concrete cone failure							
Characteristic bond resistance in cracked concrete C20/25							
dry and wet concrete: Temp. range I 5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5
dry and wet concrete: Temp. range II 5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5
dry and wet concrete: Temp. range III 5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5
flooded bore hole: Temp. range I 5): 40°C/24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible		
flooded bore hole: Temp. range II 5): 80°C/50°C	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5			
flooded bore hole: Temp. range III 5): 120°C/72°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5			
Increasing factors for cracked concrete ψ_c	C30/37		1,04				
	C40/50		1,08				
	C50/60		1,10				
Factor ref. bond strength $\tau_{Rk,c}$	k_8		7,2				
Concrete cone failure							
Characteristic edge distance	$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$				
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$				
Factor concrete cone equation	k_{cr}		7,2				
Splitting failure							
Characteristic edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$				
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)	γ_{Msp} 1)		1,8 3)				
Partial safety factor (flooded bore hole)	γ_{Msp} 1)		2,1 4)		not admissible		

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1.0$ is included.
3) The partial safety factor $\gamma_2 = 1.2$ is included.
4) The partial safety factor $\gamma_2 = 1.4$ is included.
5) Explanations see Section 1.2 of this ETA

Powers AC100-PRO Injection resin with anchor rod for concrete

Annex 32

Application with internal threaded sleeve
Design method A: Characteristic values for tension loads in cracked concrete

Design CEN/TS1992-4

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Table 34: Design according to CEN/TS1992-4 Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm							
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,25				
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,56				
Steel failure with lever arm							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,25				
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,56				
Factor bending	k_2		0,8				
Concrete pryout failure							
Factor k_3			2,0				
Partial safety factor	γ_{Mcp} [1]		1,50				
Concrete edge failure			see CEN/TS 1992-4-5, Section 6.3.4				
Partial safety factor	γ_{Mc} [1]		1,50				

[1] In absence of other national regulations

Table 35: Displacements for tension loads [1] in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Uncracked concrete							
Temperature range I 40°C/24°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,026	0,031	0,036	0,041	0,049
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,034	0,045	0,052	0,060	0,071
Temperature range II 80°C/50°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,063	0,075	0,088	0,100	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,090	0,108	0,127	0,145	0,172
Temperature range III 120°C/72°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,063	0,075	0,088	0,100	0,119
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,090	0,108	0,127	0,145	0,172
Cracked concrete							
Temperature range I 40°C/24°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,07				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,105				
Temperature range II 80°C/50°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245				
Temperature range III 120°C/72°C							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,17				
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,245				

[1] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 36: Displacement for shear load [2] in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Uncracked concrete							
Displacement	δ_{V0}	[mm/ kN]	0,05	0,04	0,04	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,08	0,06	0,06	0,05	0,04
Cracked concrete							
Displacement	δ_{V0}	[mm/ kN]	0,112	0,103	0,093	0,084	0,069
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,169	0,154	0,140	0,125	0,104

[2] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

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Annex 34

Application with internal threaded sleeve
Displacements

Design CEN/TS1992-4

Seismic design according to Technical Report "Design of Metal Anchors under Seismic Action":

The decision of selection of a higher seismic performance category than given in Table 37 is in the responsibility of each individual Member State.
Furthermore, the values $a_g \cdot S$ assigned to the seismicity level may be different in the National Annexes to EN 1998-1: 2004 (EC8) compared to the values given in Table 37.
The recommended category C1 and C2 given in Table 37 are given in the case that no National Requirements are defined.

Table 37: Recommended seismic performance categories for Anchors

Seismicity		Importance class according to EN 1998-1: 2004, 4.2.5			
	$a_g \cdot S$ 2)	I	II	III	IV
Very low 1)	$a_g \cdot S \leq 0{,}05 \cdot g$	no additional requirement			
Low 1)	$0{,}05 \cdot g < a_g \cdot S \leq 0{,}1 \cdot g$	C1	C1 3) or C2 4)		C2
	$a_g \cdot S > 0{,}1 \cdot g$	C1	C2		

1) Definition according to EN 1998-1: 2004, 3.2.1
2) $a_g = \gamma_1 \cdot a_{gR}$ Design ground acceleration on type A ground (Ground types as defined in EN1998-1:2004, Table 3.1
γ_1= Importance factor (see EN1998-1: 2004, 4.2.5)
a_{gR}= Reference peak ground acceleration on type A ground (see EN1998-1: 2004, 3.2.1)
S= Soil factor (e.g. according to EN1998-1: 2004, 4.2.5)
3) C1 for fixing of non-structural elements to structures
4) C2 for fixing of structural elements to structures

Seismic design equations to calculate characteristic seismic resistance for the relevant failure mode:

Basic characteristic seismic resistance $R^0_{k,seis}$

Tension: $R^0_{k,seis} = \alpha_{N,seis} \cdot R^0_k$
with $R^0_k = N_{Rk,s}, \tau_{Rk,cr}, N_{Rk,c}, N_{Rk,sp}$
$\alpha_{N,seis}$ = see Table 39 or Table 40 for $N_{Rk,s}$ and $\tau_{Rk,cr}$
$\alpha_{N,seis}$ = 1,0 for $N_{Rk,c}$ and $N_{Rk,sp}$

Shear: $R^0_{k,seis} = \alpha_{V,seis} \cdot R^0_k$
with $R^0_k = V_{Rk,s}, V_{Rk,c}, V_{Rk,cp}$
$\alpha_{V,seis}$ = see Table 39 or Table 40 for $V_{Rk,s}$
$\alpha_{V,seis}$ = 1,0 for $V_{Rk,c}$ and $V_{Rk,cp}$

Characteristic seismic resistance $R_{k,seis}$

Tension: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot R^0_{k,seis}$
Shear: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot R^0_{k,seis}$
with α_{seis} = see Table 38
α_{gap} = see Table 38

Seismic design resistance $R_{d,seis}$

$R_{d,seis} = R_{k,seis} / \gamma_{M,seis}$
with $\gamma_{M,seis} = \gamma_M$

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Design for seismic actions	

Table 38: Reduction factors α_{gap} und α_{seis} for resistance under seismic actions

Loading	Failure modes	α_{gap}	α_{seis} single fastener	α_{seis} fastener group
Tension	Steel failure	1,0	1,0	1,0
	Combined pullout and concrete failure	1,0	1,0	0,85
	Concrete cone failure	1,0	0,85	0,75
	Splitting failure	1,0	1,0	0,85
Shear	Steel failure without lever arm	0,5[1]	1,0	0,85
	Steel failure with lever arm	-[2]	-[2]	-[2]
	Concrete edge failure	0,5[1]	1,0	0,85
	Concrete pryout failure	0,5[1]	0,85	0,75

[1] The limitation for the size of the clearance hole is given in TR 029 Table 4.1
α_{gap}= 1,0 in case of no clearance between fastener and fixture
[2] No performance determined

Table 39: Reduction factors for seismic performance category C1 for threaded rods

Anchor size threaded rod			M 12	M 16	M 20	M24	M 27	M 30
Tension load								
Steel failure								
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0					
Combined pullout and concrete cone failure								
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,68	0,68	0,68	0,69	0,69	0,69
Shear load								
Steel failure without lever arm								
Seismic reduction factor	$\alpha_{V,seis}$	[-]	0,70					

Table 40: Reduction factors for seismic performance category C1 for reinforcing bars

Anchor size reinforcing bar			∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Tension load									
Steel failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0						
Combined pullout and concrete cone failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,68	0,68	0,68	0,68	0,69	0,69	0,69
Shear load									
Steel failure without lever arm									
Seismic reduction factor	$\alpha_{V,seis}$	[-]	0,70						

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Reduction factors for threaded rods and rebar
for design under seismic actions

Annex 36